

Training Information

Training Overview

Express Logic offers a comprehensive training program at its state-of-the-art facility in San Diego, California. The training course features hands-on embedded systems development using ThreadX, the high-performance RTOS for deeply embedded applications.

Our electronic classroom contains eight modern workstations and multimedia projection capabilities. Each attendee has individual access to a workstation that is loaded with ThreadX and other software for embedded systems applications, so the class size is limited to eight.

The training course is intensive; it combines a rich mixture of RTOS concepts and hands-on embedded systems projects that reinforce these concepts. The projects are presented in a spiral order of depth as increasingly complex embedded systems concepts are investigated and explored.

Each attendee is provided with a detailed training workbook, documentation for the lab projects, a copy of the book titled *Real-Time Embedded Multithreading*, a copy of the ThreadX User Guide, a copy of the ThreadX Programmer's Reference Guide, and a Win32 ThreadX demonstration system.



Topics Covered

Day 1		Day 2	
Morning	RTOS and MultiTasking Fundamentals 2 Lab Projects Thread Design Mutual Exclusion with Mutexes	Morning	Inter-Thread Communication with Message Queues 2 Lab Projects Priority Inversion Preemption Threshold
Afternoon	Memory Management Using Timing Facilities 2 Lab Projects Using Counting Semaphores for Event Notification Synchronizing Threads with Event Flags Groups	Afternoon	Interrupts and I/O Designing a Multi- Threaded System 2 Lab Projects Tips, Hints, and Traps



Day 1

<p>RTOS and Multithreading Fundamentals</p> <ul style="list-style-type: none">ThreadX – Origin of NameExpress Logic ProductsThe First Embedded SystemDeterminismReal-Time KernelThread ServicesPrioritiesPreemptive, Priority-Based SchedulingReal-Time Kernel SchedulingPotential Problems Caused by Preemption <p>Thread Design</p> <ul style="list-style-type: none">ThreadX ComponentsUser Guide FormatThread—Major ComponentsThread StackThread Control BlockThread Information ServicesThread ManagementThread Creation OverviewReady Thread List*Suspended Thread ListThread State TransitionQuiz—Threads <p>Mutual Exclusion with Mutexes</p> <ul style="list-style-type: none">Mutex—Major ComponentsMutex ExampleMutex ServicesPriority InheritancePrioritize Example Suspended Thread ListMutex ManagementExample of Deadly Embrace <p>Memory Management</p> <ul style="list-style-type: none">Byte Pool – Major ComponentsMemory Byte Pool ServicesMemory Byte Pool ManagementMultiple PoolsOrganization of Memory Byte PoolQuiz—Memory Byte Pools <p>Internal System Clock</p> <ul style="list-style-type: none">Timer Ticks	<p>ThreadX Project 1</p> <p>Thread Creation and Coordination using a Mutex</p> <p>Timing Facilities</p> <ul style="list-style-type: none">Timer—Major ComponentsApplication Timer ServicesTimer ManagementQuiz—Applications Timers <p>ThreadX Project 2</p> <p>Analyzing the Behavior of Threads using Timing Facilities</p> <p>Types of Program Execution</p> <p>Initialization Process</p> <p>Using Counting Semaphores for Event Notification</p> <ul style="list-style-type: none">Semaphore – Major ComponentsCounting Semaphore ExampleSemaphore ServicesSemaphore ManagementQuiz—Semaphores <p>ThreadX Project 3</p> <p>Using a Binary Semaphore in place of a Mutex</p> <p>Mutex v Counting Semaphore</p> <p>Counting Semaphore with Ceiling</p> <p>ThreadX Project 4</p> <p>Using a Counting Semaphore for Event Notification</p> <p>Synchronizing Threads with Event Flags Groups</p> <ul style="list-style-type: none">Event Flags—Major ComponentsExample of an Event Flags GroupExample of Set OperationExample of Get OperationQuiz—Event Flags Groups <p>ThreadX Project 5</p> <p>Using an Event Flags Group to Synchronize Threads</p>
---	---



Day 2

<p>Inter-Thread Communication with Message Queues</p> <ul style="list-style-type: none">Queue—Major ComponentsExample of a Message QueueMessage Queue ServicesQueue ManagementQueuing Model ClassificationQueuing ExampleQuiz—Queues <p>Memory Block Pool</p> <ul style="list-style-type: none">Major ComponentsMemory Block Pool ServicesMemory Block Pool ManagementCalculate # of Memory BlocksQuiz—Memory Block Pools <p>ThreadX Project 7</p> <p>Analyzing the Contents of a Message Queue</p> <p>Context Switching</p> <p>Typical Context Switch Actions</p> <p>Time-Slicing</p> <ul style="list-style-type: none">Round-Robin SchedulingRound Robin DefinitionRound-Robin Origin <p>Interrupts</p> <ul style="list-style-type: none">ISR TemplateThread Interrupt ManagementWhere is Context Saved? <p>Thread Starvation</p> <ul style="list-style-type: none">Priority InversionExample of Priority InversionPreventing Nondeterministic Priority Inversion ProblemsPreemption-ThresholdExample of Preemption-ThresholdMars Pathfinder	<p>Event-Chaining</p> <ul style="list-style-type: none">ObjectivesNotification capabilitiesRegistering an application functionExample of Event-Chaining <p>ThreadX Project 8</p> <p>Multiple Object Suspension System Using Event-Chaining</p> <p>ThreadX Demo System</p> <p>Tips, Hints, and Traps</p> <p>Summary and Wrap-Up</p>
---	---



Training Benefits

Although ThreadX is an easy-to-use RTOS, this training course provides an ideal way to accelerate the learning process and to obtain valuable experience in applying ThreadX to the design and implementation of your embedded application.

As a result of taking this training course, attendees will acquire an in-depth knowledge of ThreadX, and will attain a focused approach to embedded systems development. This will improve productivity and significantly reduce the time-to-market for your development project.

The hands-on component of the training course is designed to reinforce and explore ThreadX and RTOS concepts. This approach encourages attendees to become active participants by engaging them in the learning process. It also enhances retention and understanding.

This training course will provide attendees the ability to get up to speed quickly and significantly enhance the prospects of success for your project. Training will also help you to optimize your investment in the premier RTOS for deeply embedded systems.



On-Site Course

We can offer a dedicated ThreadX training course at your site, or at any location of your choosing. There are several advantages of this type of course as follows:

- Less Time Away From Work
- No Travel Costs For Employees
- Class Size Not Limited to Eight
- Course Customized For Your Development Project

Contact us for more information.



Frequently Asked Questions

I thought ThreadX was easy to use. Why do I need training?

ThreadX is widely regarded as a fast, mature, and stable RTOS. We have carefully crafted ThreadX to provide the engineer with a powerful, elegant, and simple RTOS for project development. Although using ThreadX is intuitive and straightforward, our training course can help you achieve the most from your investment. We have used our extensive experience in embedded systems to design a training program tailored to your needs.

Training is too expensive and I can't afford to take time off. Why can't I learn the same concepts on my own?

Although it is possible that you can learn the same material on your own, it will probably take you much longer and you may miss many important features and techniques. Training will reduce the time required for you to optimize the features of ThreadX, thus reducing the cost of your project. We have committed significant resources in preparing a first-rate training experience for you. Thus, the training course will provide you with focused development insight in a short period of time. If you cannot attend the training course, consider hosting an on-site course.

I'm convinced that training is essential—how do I convince my boss?

Tell him/her that time is money! As a result of this training course, you will get up to speed quickly, significantly enhance the prospects of success for your project, and substantially reduce the time-to-market for your project. Training will also help you to optimize your investment in the premier RTOS for deeply embedded systems.

Are the training sessions strictly lecture-based, or is there a hands-on component?

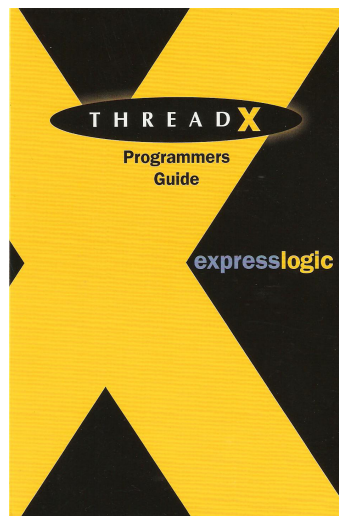
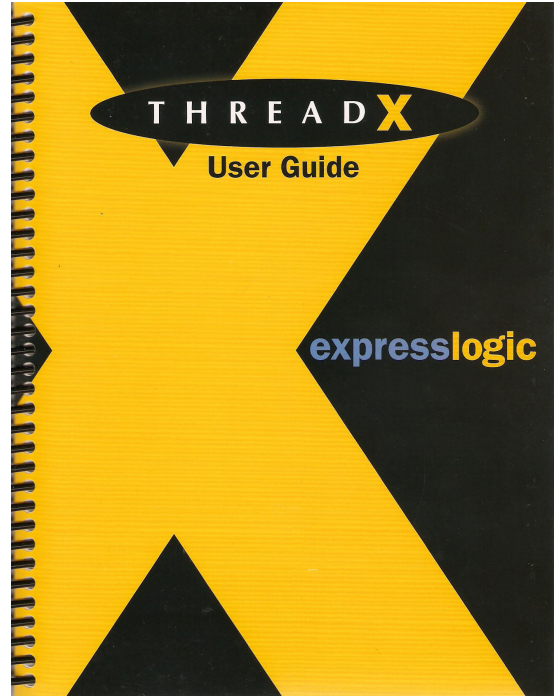
The training sessions consist of a pedagogically sound combination of lectures and hands-on embedded systems lab projects. The lab projects complement and reinforce the ThreadX and RTOS concepts discussed in the lecture. A multimedia approach is used, and the material is presented in an engaging, but fast-moving format.

What background should I have in order to take the ThreadX training course?

You should have several years of C/C++ programming experience and some exposure to embedded systems development.



Sample Training Materials



ThreadX RTOS Lab Projects

Lab Project or Topic	Page
Lab 1—Thread Creation and Coordination using a Mutex.....	2
Lab 2—Analyzing the Behavior of Threads using Timing Facilities.....	10
Lab 3—Using a Binary Semaphore in place of a Mutex.....	15
Lab 4—Using a Counting Semaphore for Event Notification.....	18
Lab 5—Using an Event Flags Group to Synchronize Threads.....	21
Lab 6—Using a Message Queue for Inter-Thread Communication.....	26
Lab 7—Analyzing the Contents of a Message Queue.....	31
Lab 8—Multiple Object Suspension System.....	35
ThreadX Case Study: Description of a Multithreaded System.....	39
ThreadX API.....	47



For More Information

Contact Ed Lamie at
ELamie@ExpressLogic.com

